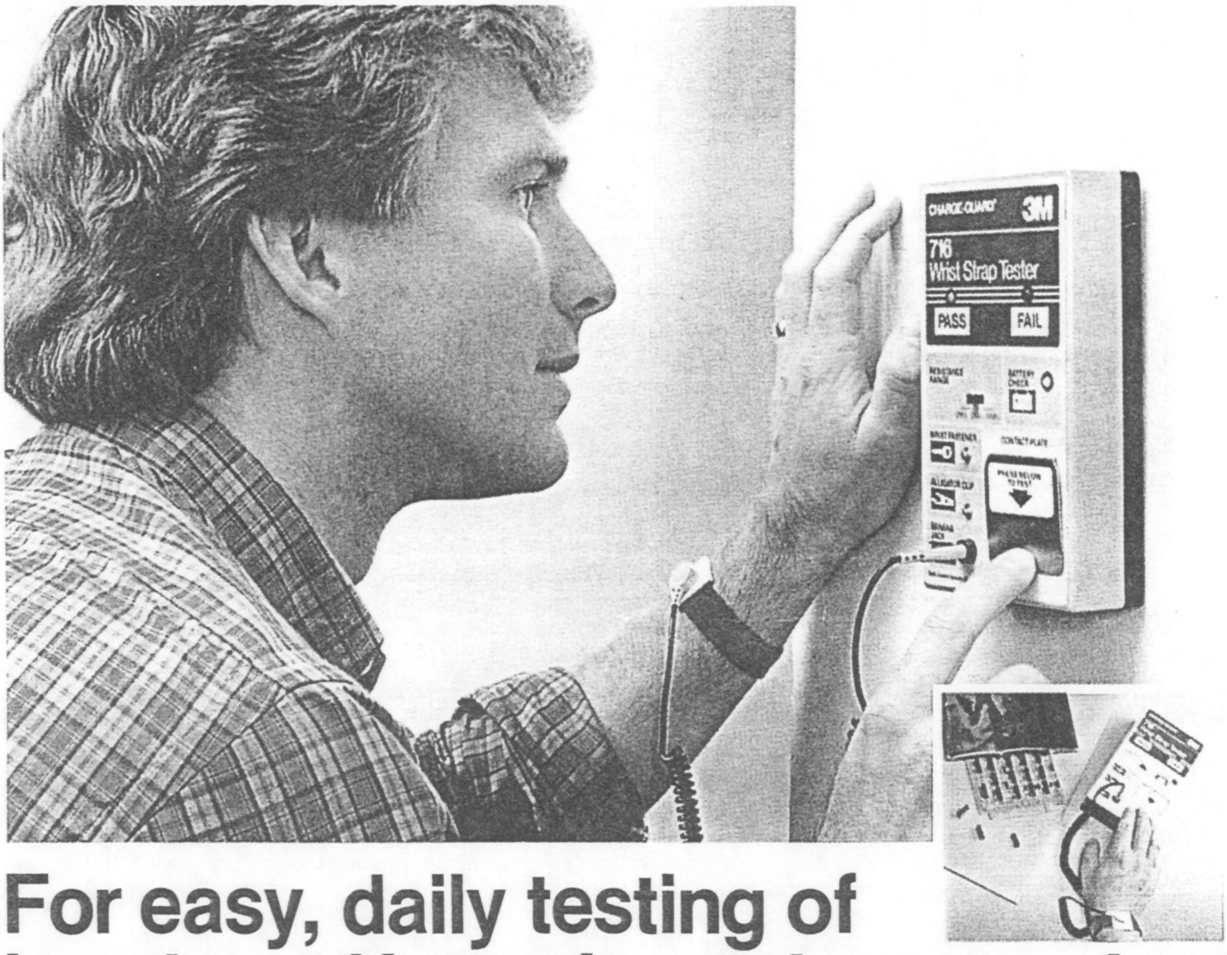
CHARGE-GUARD™ 3M

716 Wrist Strap Tester



For easy, daily testing of band, cord integrity and personal safety

Wrist straps are the first line of defense against electrostatic charge build-up on the human body. They must be able to carry away this charge as rapidly as it is generated. At the same time, a strap must remain electrically safe for the user.

For these reasons, it is important to test every wrist strap frequently and regularly.

In order to protect sensitive electronic components, the maximum strap resistance should not be more than 10 megohms. In order to protect the wearer from dangerous levels of current flow, the path to ground should have at least 500k ohms resistance.

The CHARGE-GUARD 716 Wrist Strap Tester checks this condition reliably, while the strap is on the wearer's wrist. It clearly shows whether or not the resistance of the strap system, including the wearer is at least 500k ohms and not more than 10 megohms.

If the strap system is not within 500k ohms and 10 megohms in any part, a "FAIL" indicator lamp will glow. A green "PASS" lamp indicates that the strap system is functioning properly. The 716 Tester also makes it easy to isolate a faulty component. That faulty component alone should then be replaced.

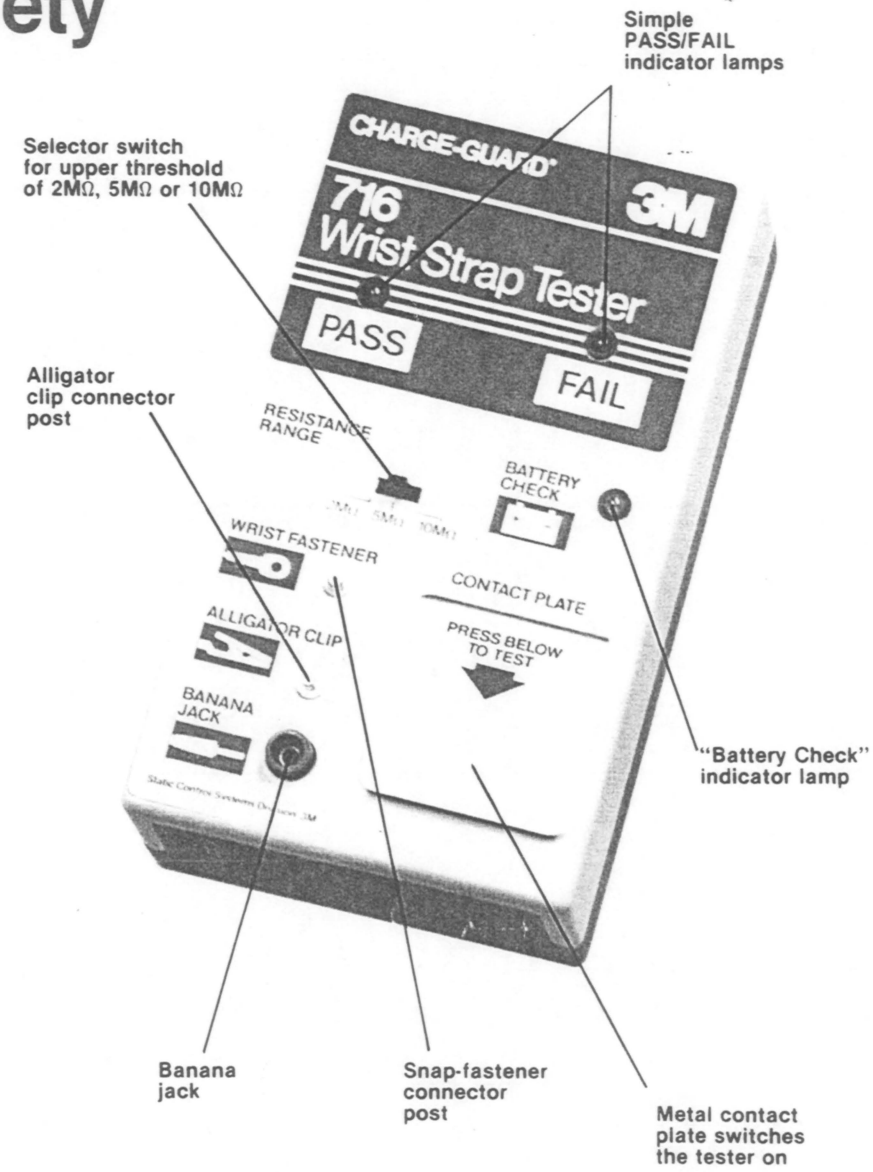
Test for device protection and personal safety

The CHARGE-GUARD 716 Wrist Strap Tester checks the integrity of the entire wrist strap system. It monitors the conductive path through the user's wrist, the band, connector, built-in resistor, cord and plug.

By simply inserting the banana plug into the socket on front of the tester, or by connecting the alligator clip to the terminal post, and then pressing on a metal contact plate, the operator can quickly see whether resistance of the wrist strap system is at least 500k ohms and not more than 10 megohms.

The tester remains in an OFF mode until the user presses the metal contact plate. At this time, a lamp indicator will light to indicate whether the wrist strap system is acceptable (green lamp), or if it contains a faulty component (red lamp).

If the wrist strap system proves faulty, the user can further isolate the nature of the problem by removing the snap-fastener from the wrist band and attaching it to a post on the tester. Pressing the metal contact plate indicates that the problem is in the cord (if the red lamp lights). If the green lamp lights, the problem is elsewhere.



Specifications

3M Brand 716 Wrist Strap Tester

Dimensions:	1 3/4 × 4 5/16 × 7 3/8 in. (44.5 × 109.5 × 187.3 mm)
Weight:	1.0 lb. (453.6g)
Power Requirements:	6 volts
Battery:	Four 1.5 volt (AA) cells
Line Supply:	110 volt AC
Test Voltage:	20 volts

AC Line Adapter (supplied)

Input:	120 volt AC 60 Hz 5 W
Output:	6 volts DC 150 mA

Important Notice to Purchaser:

Warranty—3M expressly warrants that for a period of ninety (90) days from the date of purchase 3M static control products will be free of defects in materials (parts) and workmanship (labor).

Defects occurring during the warranty period will be repaired, or products will be replaced at 3M's option and expense, if 3M receives notice during the warranty period. Defective products must be returned to 3M with proof of purchase date.

Warranty Exclusions—THE FOREGOING EXPRESS WARRANTY IS MADE IN LIEU OF ALL OTHER PRODUCT WARRANTIES, EXPRESS AND IMPLIED, INCLUDING FITNESS AND MERCHANTABILITY. The express warranty will not apply to defects or damage due to accidents, neglect, misuse, alterations, operator error, or failure to properly maintain, clean, or repair products.

Limit of Liability—In no event will 3M or Seller be responsible or liable for special, incidental or consequential losses or damages, whether based in tort or contract. Fulfillment of 3M's warranty obligations will be Customer's exclusive remedy and 3M's and Seller's limit of liability for any breach of warranty or otherwise.

98-0798-1147-1(16.10)BP

Static Control Systems Division/3M
P.O. Box 2963
Austin, TX 78769-2963

3M

Operating Instructions

716
Wrist Strap Tester

INTRODUCTION

The 3M Model 716 Wrist Strap Tester is designed to measure a person's resistance while wearing a wrist strap assembly. The tester will indicate if a person is above or below a static safe resistance. It will also isolate defective areas within the wrist strap assembly. The user can quickly determine their resistance condition with the tester.

If a person's resistance to ground is too high, harmful levels of static electricity could be generated on the person's body. If it is too low, an electrical shock hazard could exist. The 716 tester is designed to indicate if a person's resistance is between 10 megohm and 500,000 ohms (internally set). If more accurate values are needed, a resistance measurement with an ohmmeter is required (please refer to pages 2 and 3, "Why Wrist Straps Are Needed And A Method For Testing Them).

INSTRUCTIONS

A. Testing the Batteries

Depress the metal contact plate fully. Observe the battery check lamp (amber). If the lamp is ON, the batteries are operational; if not, replace the batteries.

NOTE: The battery indicator lamp should be ON whenever the metal contact plate is activated. If the lamp turns off during a test, stop the test and replace the batteries.

B. Taking Measurements

Select the desired upper maximum resistance level with the selector range switch.

10MΩ – Ten Megohm maximum allowable resistance level for the total system (person included) to be static safe.

5MΩ – Five megohm optional resistance level. This level can be used to determine a more definite measurement if desired.

2MΩ – Two megohm resistance level used to test the ground cord.

Total System Test:

1. Connect the personnel ground cord (banana plug end or alligator clip end) to the identified terminal on the tester. With the personnel wrist band on the wrist, connect the other end of the ground cord (snap end) to the wrist band.

2. Depress the metal contact plate fully with the bare fingers of either hand and observe the PASS – FAIL indicator lamps.

   If the PASS (green) lamp is on, this indicates that the resistance being measured is less than the upper limit selected but greater than the minimum 500,000 ohms (internally set).

   If the FAIL (red) lamp is on, this indicates that the resistance may be greater than the upper limit selected or lower than the minimum 500,000 ohms (internally set).

   If both lamps are on at the same time, this indicates that the resistance of the wrist strap being tested is at the level selected by the selector range switch

   NOTE: If the FAIL lamp turns on during the test, check to see if the personnel wrist band is being worn correctly. The band should fit the wrist snugly. (See instructions which were included with the purchase of the wrist band).

   If the FAIL lamp remains on, proceed to the CORD TEST.

CORD TEST

Leave the banana plug or alligator clip of the personnel ground cord attached to the tester. Disconnect the snap end of the ground cord from the wrist band and connect it to the identified terminal on the tester.

Select the 2MΩ level with the selector range switch.

Proceed as in step 2 of Total System Test above.

If the FAIL lamp is ON, replace the ground cord.

If the PASS lamp is ON, the ground cord is OK or check for other possible conditions in the system:

1. Intermittent continuity in the ground cord.

2. Intermittent continuity between the snap end of the ground cord and the wrist band.

3. Poor contact between the wrist band and the wrist (dry skin-hairy wrist) or defective wrist band.

Why Wrist Straps Are Needed And A Method For Testing Them

WRIST STRAPS

The purpose of a wrist strap is to maintain a continuous effective contact between ground and the worker. The voltages that might otherwise be created on the ungrounded worker either triboelectrically or by capacitive changes are eliminated or at least reduced to magnitudes not harmful to devices.

Voltage Monitoring Test

The most difficult to control static voltage variations are those created by capacitance changes due to simple physical movements made by the worker. For example, as a worker at a wave solder machine walks, or as a seated worker lifts both feet up onto a foot rest, or stands up, voltages are often created that are capable of damaging or degrading electronic components.

The voltage on a worker can be monitored during work related motions without significantly affecting that voltage, using a capacitive voltage probe attached to a Keithley 610C electrometer and recorded on an oscilloscope (Figure 1). A one inch diameter, three inch long, #304 stainless steel electrode held in the worker's hand provides reliable electrical contact with the capacitive voltage probe.

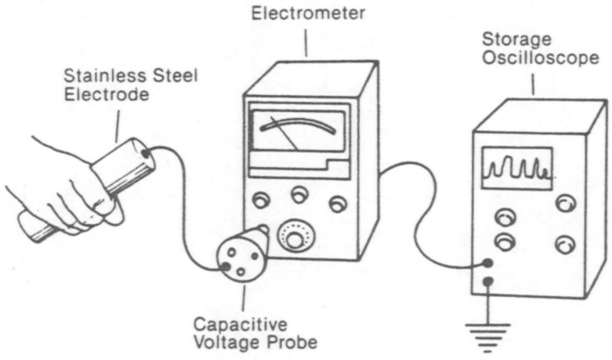


Figure 1. Voltage monitoring test apparatus for a person.

The trace reproduced as Figure 2 is typical of the voltage pulses measured for several ungrounded individuals making the indicated movements. In each case, the maximum rate of voltage increase occurred when the person was seated and raised both feet suddenly from the floor. Voltage changes of 1,500 volts in magnitude rates (dV/dt) as high as 5,000 volts per second were noted during this movement.

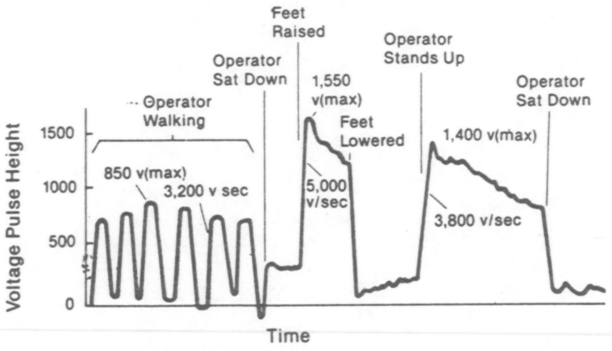


Figure 2. Typical voltage variations monitored on a person with no wrist strap.

The maximum magnitude of the voltage peaks produced during this series of actions was monitored for a number of people each wearing a snug fitting wrist strap. The resistance to ground provided to each person by the wrist strap was varied, and the maximum transient voltage peaks observed are shown in Table 1.

Table 1

Transient Voltage on a Person vs. Resistance to Ground

Peak Voltage (volts)	Resistance to Ground (megohms)
<2	0.27
<2	1
11	10
30	50
80	100
1,550	∞(no wrist strap)

Based on the data in Table 1, it was empirically determined that a wrist strap resistance to ground of 10 megohms or less should prevent the worker from developing damaging potentials. This test accurately indicates the ability of a wrist strap to function properly, its only drawback being that the amount of equipment required limits the test's use for periodic wrist strap evaluations in a manufacturing facility.

Resistance Test

The testing of a wrist strap can conveniently be accomplished by a resistance measurement from the worker to ground. The ground lead of an ohmmeter is attached to the ground connection of the wrist strap, and the positive lead is attached to the previously described stainless steel monitoring electrode, which is placed in the worker's hand (Figure 3).

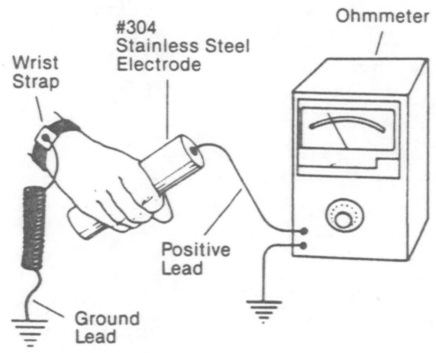


Figure 3. Wrist strap resistance test apparatus.

During resistance measurements of this type a combination of galvanic action and human biopotential effects (muscle contractions, skin stretch, etc.) can result in a small flow of current from a person (on the order of 10 to 100 nanoamps) depending on the wrist cuff material, the metal used for the monitoring electrode, and the person's movements. If the current used by the ohmmeter to make the measurement is close to the "human battery" current, the reading will be affected by the orientation of the meter's leads. If the leads are connected in one direction, this galvanic current adds to the current from the meter, and the indicated resistance is much smaller than the true value. If the leads are reversed, the galvanic current opposes the meter's current, thus increasing the indicated resistance. This was found to be a very significant problem with low voltage (1.5 volts or less) ohmmeters such as many digital types which generally operate at currents of under 10 nanoamps when making one megohm resistance measurements. This "human battery" effect was minimized (<5 nanoamps) for the wrist straps tested by using #304 stainless steel for the electrode material.

The total resistance to ground of the worker is made up of three series resistances: (1) the contact resistance between the strap's cuff and the person's skin; (2) the resistance through the safety resistor; and (3) the resistance through the ground cord. It is the contact resistance across the skin-cuff interface which is the most significant and most variable of these series resistances. For this reason a resistance test measurement, if it is to determine the efficacy of the wrist strap, must include the worker.

There are factors influencing the contact resistance between the worker's arm and the wrist strap. The contacting surfaces of the wrist strap are the metal or carbon loaded plastic cuff of the wrist strap and the worker's skin. The voltage dependence of this contact resistance is determined by the physical and electrical surface characteristics of the cuff, the texture and dryness of the worker's skin, the amount of interfering hair, and most predominantly, how snugly the cuff fits the wrist.

The voltage-current requirements necessary to make a meaningful wrist strap resistance determination were experimentally determined by measuring the resistance to ground of several people wearing a variety of commercially available generic types of wrist straps at various voltages. Each of these straps was functionally tested as described previously and tightened or otherwise adjusted to assure it was being worn properly.

The maximum values of resistance to ground at each voltage for the person/wrist strap combinations tested all fell beneath the dashed line shown in Figure 4. The measured values of resistance to ground were most consistent at voltages of 20 volts and higher. Below 10 volts the measurements were quite variable and therefore not always indicative of the actual resistance to ground provided by the strap. It was found that for a beaded chain type wrist strap, resistance measurements were erratic regardless of the test voltage because of intermittent loose contact.

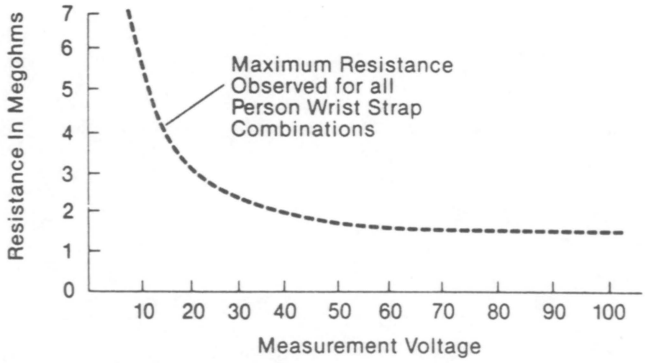


Figure 4. Resistance to ground of people wearing various wrist straps with respect to measurement voltage.

There are a number of commercially available meters which can be used to make wrist strap measurements at 20 volts or higher and which use sufficient current to overcome the human battery effects. For example, the Simpson Model 269 and Triplett Model 630-PL portable meters have 0-200 and 0-100 megohm scales. These two meters were found to read wrist strap resistances of 10 megohms at 20 and 30 volts using currents of 0.2 and 0.3 microamps, respectively. In addition the Biddle Portable Megger™ has even higher scales and measures resistance to ground at 100 volts using a current of 10 microamps.

3M Austin Calibration Laboratory

6801 Riverplace Boulevard
PO Box 2963
Austin, TX 78769-2963

CERTIFICATE OF CALIBRATION

3M Wrist Strap Tester

Model# 716	Cal Date: 01-09-93
Serial# 24817	Due Date: 01-09-94
3M# 24817-WS	Received: In-Spec

3M certifies that the above instrument meets or exceeds all published specifications. This instrument has been calibrated using standards and instruments whose accuracies are traceable to the National Institute of Standards and Technology, an accepted value of a natural physical constant or a ratio calibration technique.

All calibration measurements performed at the 3M Austin Calibration Laboratory comply with both MIL-STD-45662A and ISO 9002.

Temperature: 70 °F Humidity: 50 % R.H.

Standards used: 39692 81490

Comments: Performance test only. Unit not adjusted.

Daniel Garza II
Certifying Authority
3M

3M MODEL 716 VERIFICATION DATA SHEET

CUSTOMER NA

SERIAL NUMBER 24817

INSPECTOR J.T. DATE 9 JAN. 93

PARAMETER VERIFICATION		CRITERIA	AC ADAPTER		BATTERY	
RSB (Ω) Setting	Resistance Setting	Lamp Indication	TEST RESULT PASS	FAIL	TEST RESULT PASS	FAIL
450K	10MΩ Range	FAIL	✓		✓	
	5MΩ Range	FAIL	✓		✓	
	2MΩ Range	FAIL	✓		✓	
550K	10MΩ Range	PASS	✓		✓	
	5MΩ Range	PASS	✓		✓	
	2MΩ Range	PASS	✓		✓	
9M	10MΩ Range	PASS	✓		✓	
11M	10MΩ Range	FAIL	✓		✓	
4.5M	5MΩ Range	PASS	✓		✓	
5.5M	5MΩ Range	FAIL	✓		✓	
1.8M	2MΩ Range	PASS	✓		✓	
2.2M	2MΩ Range	FAIL	✓		✓	
Battery Check		Indicator Lamp ON	YES	NO	YES	NO
			✓		✓	
Did customer return AC Adapter with 716 Tester?					✓	

Instructions

Using the 705 Bag Check

I. Battery test

Turn the 705 on using the on/off switch located at the lower left side of the unit. The Yellow LED low battery indicator should illuminate for approximately two seconds and then turn off. If it remains on, replace the battery. If the Yellow LED should illuminate and remain on while using the 705, replace the battery.

II. Taking measurements

Turn the tester on and observe the battery condition as described above. Select the desired Ω range by moving the Ω range select switch at the top of the tester.

Insert the open end of the bag about 1.0 inch into the 705. Avoid placing the printed area of the bag between the two electrodes (See Figure 1). Press down firmly on the paddle as indicated to make contact to the bag.

Figure 1

If the Green LED is illuminated, the resistance of the bag is equal to or less than the range selected.

If the Red LED is illuminated, the resistance of the bag is higher than the range selected.

The graph shown in Tech Brief No. 120, included with the 705, will give you an indication of the shielding effectiveness of the bag, based upon the resistance of the bag being tested.

Testing the Bag Check Calibrator for the 705

Any out of tolerance reading indicates a defective calibrator and it should be removed from service.

Equipment needed:
Calibrated 3-1/2 digit, Digital Multi Meter (DMM) Fluke 8020A or equivalent

1. Set DMM to measure resistance on the 2K ohm range.
2. Set Bag Check Calibrator range switch to 1K and LED switch to Green.
3. Hold one DMM test lead on the top side of Calibrator probe, and the other on the bottom side of probe (polarity does not matter). Be careful not to short across probe with test leads. All measurements will be made with test leads applied in this manner. (See Figure 2).
4. Verify a DMM reading of 988 to 1012 ohms (1K ohms +/−1.2%).

I. Preparation

1. Set the Bag Check power switch to off.
2. Carefully remove the Bag Check battery cover located on the bottom rear of the unit, and remove the battery and AC adaptor.
3. Remove the four screws located at each bottom corner of the Bag Check.
4. Carefully lift the top portion of the enclosure from the bottom and lay the top on its side next to the bottom. Be careful not to damage any of the wires inside the unit.
5. Turn the DC supply on and connect the DMM test leads to the supply output and adjust for a 9.00 volt level.
6. With the DC supply turned off, connect it to the battery clip ensuring the polarity matches that of the battery when installed.
7. Turn on power supply and Bag Check.

II. Range Calibration

1. Refer to Figure 4 for adjustment locations throughout this procedure.

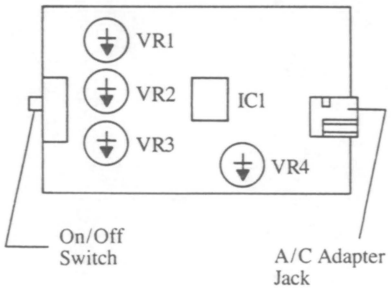


Figure 4

2. Set the Calibrator and Bag Check range switches to 50K. Set the Calibrator LED switch to Green.
3. Hold the Calibrator probe between the Bag Check contacts by pressing down on the Bag Check paddle until the probe is held in place. The Calibrator probe must remain clamped in the contacts for each of the adjustments and tests in this section of the procedure.
4. Adjust VR3 back and forth a few times around center travel of the potentiometer causing the Bag Check LEDs to switch from Red to Green. Then carefully set the potentiometer just to the point where the LEDs switch from Red to Green. This point of adjustment should ensure the Red LED is off and the Green LED is on, not a simultaneous Red and Green indication. If this does not occur, readjust the VR control until proper operation is obtained.
5. Slide the Calibrator LED switch between Red and Green a few times and check that only the Red LED is on in the Red position, and only Green in the Green position.
6. Set the Calibrator and Bag Check range switches to 10K. Set the Calibrator LED switch to Green.
7. Repeat steps 4 and 5 using VR2 for the adjustment.
8. Set the Calibrator and Bag Check range switches to 1K. Set the Calibrator LED switch to Green.
9. Repeat steps 4 and 5 using VR1 for the adjustment.

5. Set Calibrator LED switch to Red.
6. Verify a DMM reading of 1087 to 1113 ohms (1.1K ohms +/−1.2%).
7. Set DMM range switch to 20K.
8. Set Calibrator range switch to 10K and LED switch to Green.
9. Verify a DMM reading of 9.88K to 10.12K ohms (10K ohms +/−1.2%).
10. Set Calibrator LED switch to Red.
11. Verify a DMM reading of 10.37K to 10.63K ohms (10.5K ohms +/−1.2%).
12. Set DMM range switch to 200K.
13. Set Calibrator range switch to 50K and LED switch to Green.
14. Verify a DMM reading of 49.4K to 50.6K ohms (50K ohms +/−1.2%).
15. Set Calibrator LED switch to Red.
16. Verify a DMM reading of 50.4K to 51.6K ohms (51K ohms +/−1.2%).

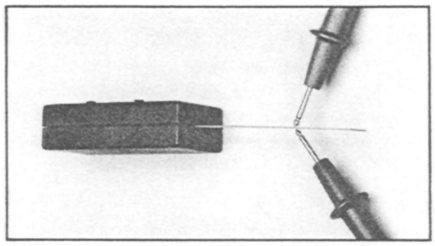


Figure 2

Using the 705 Bag Check Calibrator

Periodically test the calibration of the 705 Bag Check using the Bag Check Calibrator (See Figure 3). Test each resistance range of the 705 for both Red and Green indications by selecting the equivalent resistance range on the Calibrator. With the Green selected on the calibrator, the Green LED on the Bag Check should be illuminated when tested as shown in Figure 3. With the Red selected on the Calibrator, the Red LED on the Bag Check should be illuminated. If this does not occur, the 705 Bag Check should be readjusted according to the calibration instructions found in this booklet.

NOTE: Be certain the 705 Bag Check Calibrator is within tolerance before adjusting the 705 Bag Check.

Figure 3

Calibrating the 705 Bag Check

The accuracy of the 705 Bag Check can be tested by using it with the Bag Check Calibrator included.

Equipment needed:
Bag Check Calibrator
Adjustable 0-10 volt DC voltage supply
Calibrated 3-1/2 digit, Digital Multi Meter (DMM)

III. Battery Monitor Calibration

1. While monitoring the DMM reading, adjust the DC supply for a 7.50 volt level.
2. Adjust VR4 to just turn on the Yellow low battery LED.
3. Set the DC supply output back to 9.00 volts and verify that the Yellow LED is off.
4. Slowly turn the DC supply output down while monitoring the Yellow LED. Stop turning when the Yellow LED turns on. Verify the DMM reading is 7.5 volts +/– 0.2 volts.
5. Set the Bag Check power switch to off. Disconnect the DC supply from battery clip.
6. Reassemble Bag Check.
7. After reassembly, turn Bag Check on and verify the low battery indicator LED illuminates for approximately two seconds and then turns off.

AC Adapter Plug

Dimensions for the AC adapter plug are: 0.472 in. (11.99mm) long; 0.217 in. (5.5mm) diameter; 0.083 in. (2.1mm) inside hole diameter.

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Limit of Liability—In no event will 3M or Seller be responsible or liable for special, incidental, or consequential losses or damages, under any legal theory including but not limited to contract, negligence or strict liability. Fulfillment of 3M's warranty obligations will be Customer's exclusive remedy and 3M's and Seller's limit of liability for any breach of warranty or otherwise.

34-7030-0456-3(312.5)LP

3M Electrical Specialties Division

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3M

Tech Brief

3M

Date: February 1991
No.: 120

Evaluation of Static-Shielding Film Products

Introduction to bag/pouch testing

Flexible static-shielding products provide electrostatic protection to items enclosed as long as a suitable level of surface resistance and enclosure resistance (resistance around the bag/pouch) is maintained. Since the invention of static-shielding film products, users have been concerned about qualification, inspection and performance testing of these products. 3M 2100 and 2100E families of flexible packaging products have an accessible layer of metallic nickel that allows easy measurement of both sheet resistance (sides) and enclosure resistance. Correlation of the resistance measurements to electrostatic shielding has been the subject of numerous technical papers and discussions since 1979 (ref. 1,2,3,4). 3M developed a shielding test method that uses a capacitive probe which responds to the induced pulse across the interior of a bag/pouch after an exterior discharge. This method is described in EIA-541 appendix E. While many companies have successfully implemented this test method and use it routinely, many others view it as being difficult to set up and interpret.

The original intent of the capacitive probe test was to provide a means of comparison of different bag constructions. When used correctly, the test is run with bags made of plain plastic (intuitively provides little shielding) and a bag made of heavy metal film with insulative or dissipative plastic interior (intuitively a good shield) to define the range or spectrum of electrostatic shielding. These bags thus become the standards or "ruler" to which all other bags are compared. Bags or pouches are tested using the same parameters as the standards and a ranking order of performance can be made. This type of testing is useful during the qualification stage when bags are being selected for procurement. Once an acceptable product is selected, the test method can be used to audit bags from stock or from the manufacturing floor.

Capacitive probe test methods

Two principle circuits are used to deliver a controlled discharge for capacitive probe testing. The first is known as the "military human body model" (HBM) which uses an RC circuit incorporating a 1.5k ohm resistor and a 100pF capacitor. Test voltage is usually 1000V although any voltage can be used up to the limit of the switches or relays used to deliver the pulse. The other RC circuit is known as the "EIA" model which uses a 400k ohm resistor and 200pF capacitor. The test voltage is also variable depending on need.

The HBM produces a fast rise time pulse that allows observation of very small differences between bags under test. The EIA model produces a slower pulse that simulates the measured discharge pulse intensity from the finger tip discharge of several investigators (ref 3).

While neither of these models predict precisely what will happen inside a bag under every circumstance, results can be correlated to protection levels afforded to electronic components or devices that have been tested in the same fashion.

Realistically, the value of these tests is to show initial performance, relative to standards ("ruler") and to provide a qualitative means to monitor performance of selected samples of bags while in use. The evaluator should keep in mind that the shielding ability of a bag/pouch is influenced by the electrical resistance of the sides, the enclosure resistance, the overall size of the bag/pouch and the actual magnitude of the charge delivered.

Testing with Bag Check

Since the capacitive probe test is rather complex to set up and run for routine testing, many bag users will choose not to evaluate bags/pouches. **However, since flexible packaging materials have finite use life, a method of evaluation should be provided by bag/pouch manufacturers, so that users will know how to detect a bag/pouch that has reached the end of its service life.** 3M Model 2100 and 2100E products can be evaluated by simple enclosure resistance measurements that are correlated directly to capacitive probe and electronic component protection tests (ref. 1,2,3,4).

Resistance measurement around the enclosure formed by a bag were discussed by Huntsman, Yenni and Mueller in 1980 (ref. 2). In 1984, 3M released a Technical Response paper (ref. 5) which described a simple means to make the enclosure measurement with a standard ohmmeter. Today, a simple tester, the 3M 705 Bag Check, is available for use with 3M 2100 and 2100E Static-Shielding Bags. Three resistance ranges are selectable on the instrument which can be used to evaluate bags/pouches. The following Table *provides guidelines* to aid in the interpretation of the resistance ranges and light indicators on the Bag Check.

Table 1

Slide Switch Position	Indication		Condition/Suggested Disposition*
	Green	Red	
1k Ohms	X		New to slightly used
		X	Go to next range
10k Ohms	X		Should be acceptable for reuse
		X	Go to next range
50k Ohms	X		$<$8″x10″ dispose, $\geq$8″x10″ should be OK for many applications
		X	Dispose

*Suggestions for the disposition of bags/pouches are based on the protection provided to 200 volt sensitivity level MOSFETS (3N157) in 8″x10″ 3M model 2100/2100E Static-Shielding Bags. The discharge level from the investigators was $>$10kV (ref. 3).

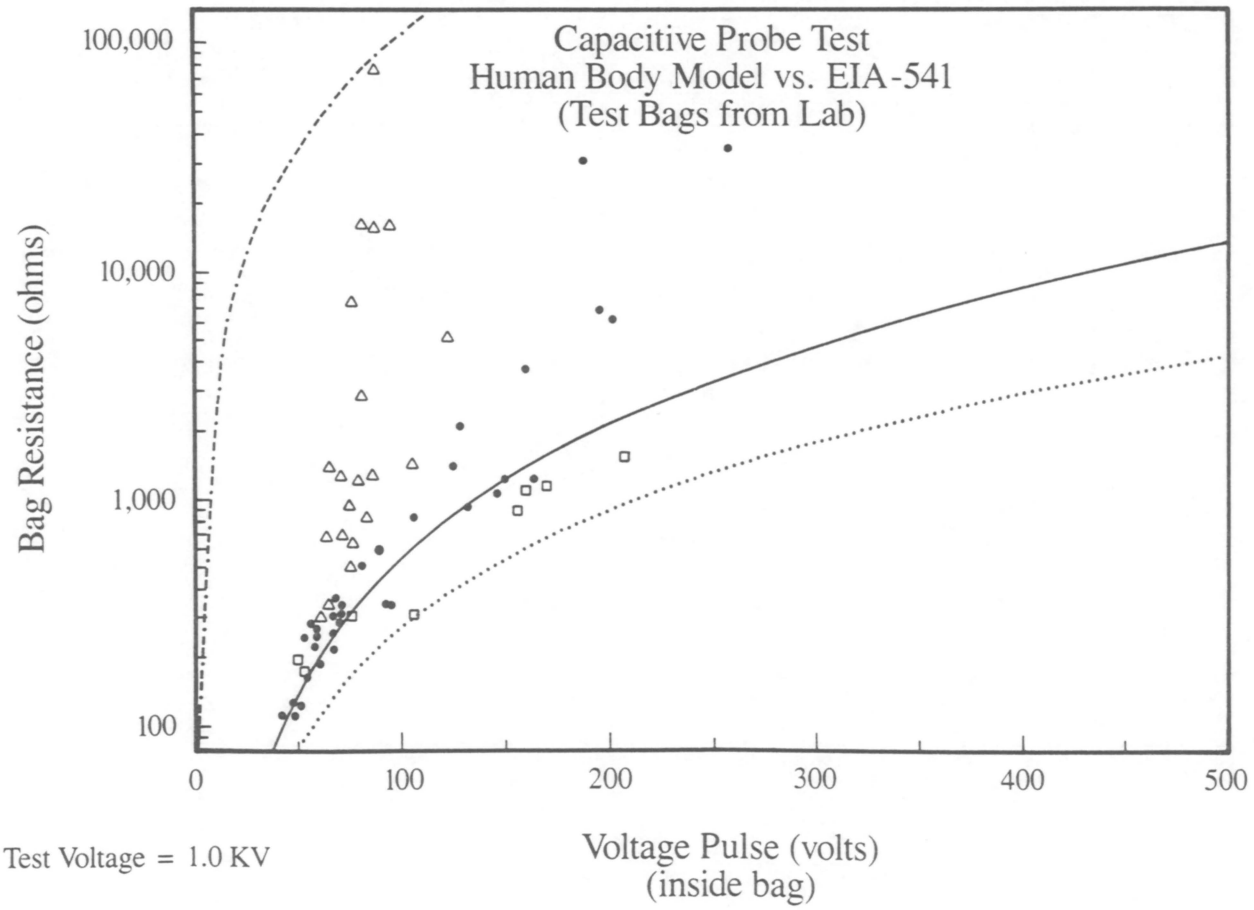
Supporting Information

Figure 1 shows a graph that plots measured enclosure resistance vs. voltage pulse via capacitive probe testing using both of the referenced discharge circuits. The solid line represents bags that were purposely damaged by the "snowball" technique (hand crumpling a bag repeatedly as in making a snowball). The resistance was measured and recorded between snowball cycles. Capacitive probe testing using the "HBM" circuit followed each significant resistance increase. The dashed line represents bags treated the same way but capacitive probe tested with the "EIA" model.

Figure 1 also has numerous "points" that represent enclosure resistance and capacitive probe ("HBM") tests on a limited quantity of bags returned from actual use in the field. Bags ranged in size from 4"x4" to 10"x12". As can be observed, most of the points are located between the lab test lines. The small bags (4"x 4" and 5"x 8") tend to be located near the "HBM" test line thus, supporting the statements and suggestions in the table regarding bag size being an important consideration in choosing disposal levels. The dotted line is the calculated statistical 95% confidence interval for the "HBM" test results.

One of the bags evaluated had a "red light" indication at the 50k ohms setting and would have been an automatic candidate for disposal. However, capacitive probe testing shows that this bag still provides a reasonable measure of shielding ability (87 volt pulse) due, at least in part, to the larger size (10"x 12"). In practical terms, this bag should still perform adequately for many applications. The resistance ranges and the accompanying disposition suggestions are based on testing devices sensitive to 200 volts. Devices sensitive to lower voltages would require bag/pouch disposal at a lower enclosure resistance while devices not so sensitive would allow a higher enclosure resistance level prior to bag/pouch disposal.

Figure 1



Summary

1. Bag/pouch testing should be required to assure adequate shielding protection for bag/pouch reuse situations.
2. Capacitive probe testing (EIA-541 and HBM) provides a "ruler" to guage relative static-shielding performance.
3. Enclosure resistance is directly correlatable to the degree of shielding performance.
4. Bag/pouch enclosure resistance disposal level should be correlated to device sensitivity.
5. Bag/pouch size must be considered when establishing disposal level. Suggested beginning points: $>8''$x $10''$ dispose at >50k ohms; $<8''$x $10''$ disposal level determined by device sensitivity. Refer to figure 2 for guidelines.

References

1. D.M. Yenni, Jr. and J.R. Huntsman, "The Deficiencies in Military Specification MIL-B-81705: Considerations and a Simple Model for Static Protection," Proc. Reliability Analysis Center, EOS/ESD Symposium 1979, pp. 45–54.
   Describes capacitive probe testing and the mathematical models used in the derivation of the test. The specifications used to establish the principles of electrostatic shielding are described.
2. J.R. Huntsman, D.M. Yenni, Jr. and G.E. Mueller, "Fundamental Requirements For Static Protective Containers," Proc., Technical Program, NEPCON/West, 1980, Vol. 1, pp. 624–635.
   Improves upon the model established in ref. 1. Compares surface conductive materials and volume conductive materials. Flexible and rigid protective packaging materials are described.
3. J.R. Huntsman, D.M. Yenni, Jr., "Test Methods for Static Control Products," Proc., 1982 EOS/ESD Symp., Reliability Analysis Center, Griffiss AFB, NY 13441, pp. 94–109.
   Compares "HBM" capacitive probe testing with the then proposed "EIA" Model. Protection levels afforded by packaging at various resistance levels are compared to 200V sensitivity devices.
4. J.R. Huntsman, "Practical Aspects of Static Discharge Protection Testing of Bags," Evaluation Engineering, May 1984.
   Provides hints and procedures to set-up, run and interpret capacitive probe tests.
5. Tech Response No. 110, "3M Model 2100 Static-Shielding Bag Test Procedure," May 1, 1984.

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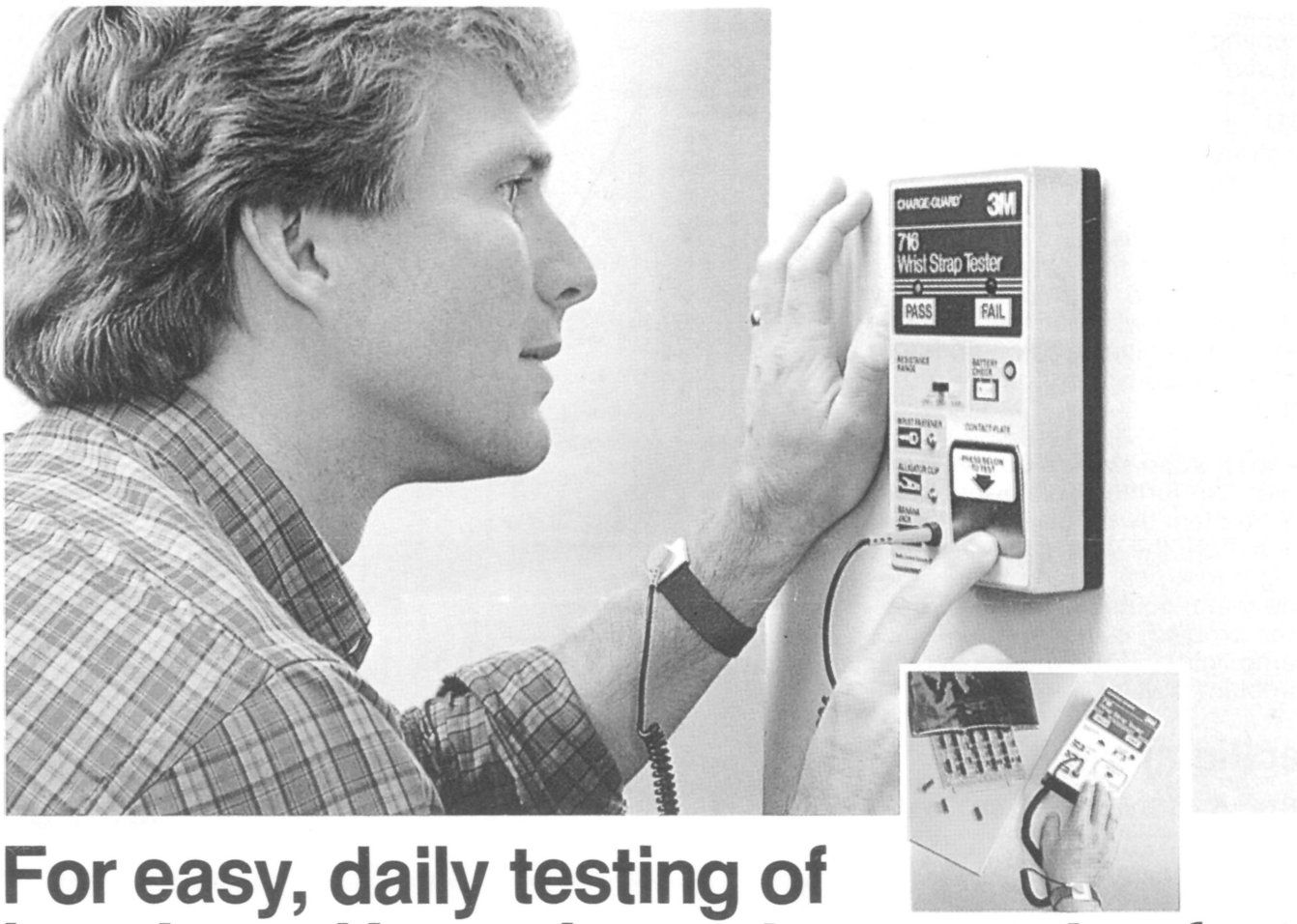
CHARGE-GUARD™ 3M

716 Wrist Strap Tester



For easy, daily testing of band, cord integrity and personal safety

Wrist straps are the first line of defense against electrostatic charge build-up on the human body. They must be able to carry away this charge as rapidly as it is generated. At the same time, a strap must remain electrically safe for the user.

For these reasons, it is important to test every wrist strap frequently and regularly.

In order to protect sensitive electronic components, the maximum strap resistance should not be more than 10 megohms. In order to protect the wearer from dangerous levels of current flow, the path to ground should have at least 500k ohms resistance.

The CHARGE-GUARD 716 Wrist Strap Tester checks this condition reliably, while the strap is on the wearer's wrist. It clearly shows whether or not the resistance of the strap system, including the wearer is at least 500k ohms and not more than 10 megohms.

If the strap system is not within 500k ohms and 10 megohms in any part, a "FAIL" indicator lamp will glow. A green "PASS" lamp indicates that the strap system is functioning properly. The 716 Tester also makes it easy to isolate a faulty component. That faulty component alone should then be replaced.

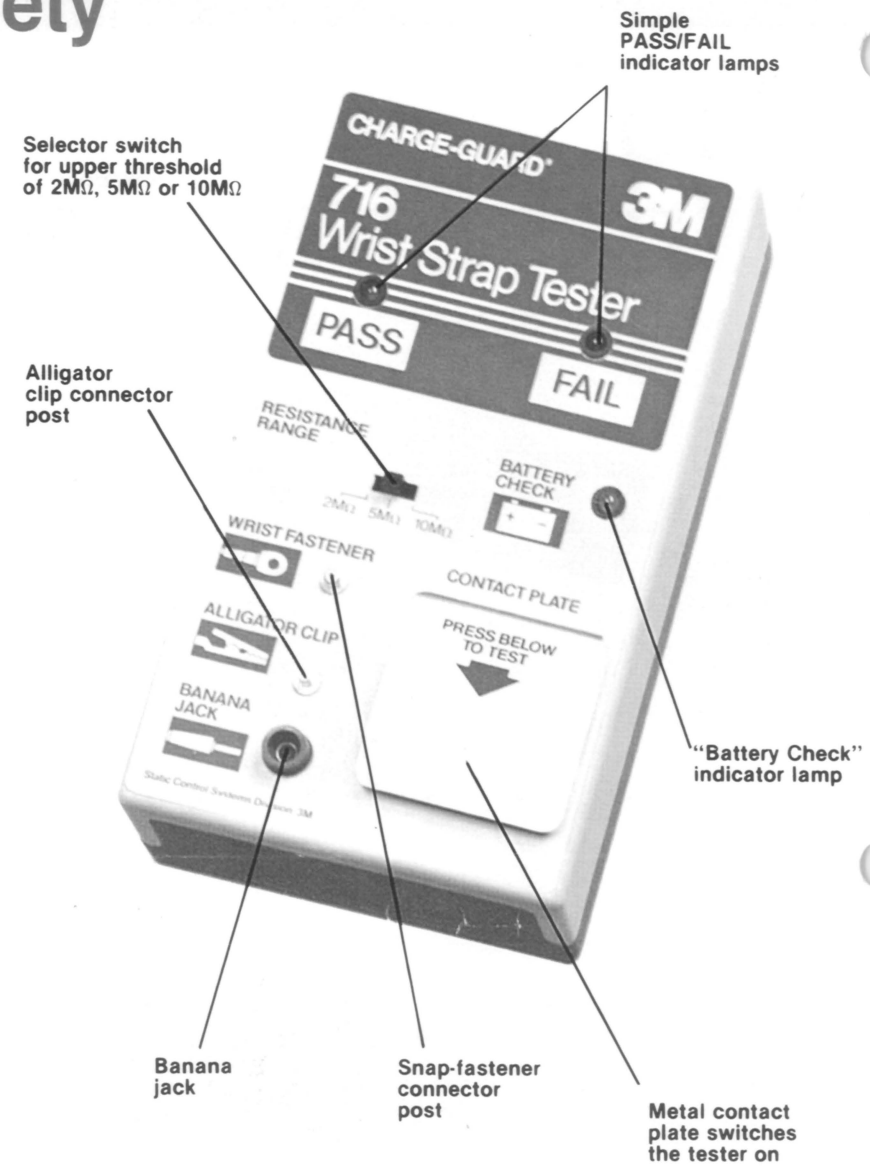
Test for device protection and personal safety

The CHARGE-GUARD 716 Wrist Strap Tester checks the integrity of the entire wrist strap system. It monitors the conductive path through the user's wrist, the band, connector, built-in resistor, cord and plug.

By simply inserting the banana plug into the socket on front of the tester, or by connecting the alligator clip to the terminal post, and then pressing on a metal contact plate, the operator can quickly see whether resistance of the wrist strap system is at least 500k ohms and not more than 10 megohms.

The tester remains in an OFF mode until the user presses the metal contact plate. At this time, a lamp indicator will light to indicate whether the wrist strap system is acceptable (green lamp), or if it contains a faulty component (red lamp).

If the wrist strap system proves faulty, the user can further isolate the nature of the problem by removing the snap-fastener from the wrist band and attaching it to a post on the tester. Pressing the metal contact plate indicates that the problem is in the cord (if the red lamp lights). If the green lamp lights, the problem is elsewhere.



Specifications

3M Brand 716 Wrist Strap Tester

Dimensions:	1 3/4 × 4 5/16 × 7 3/8 in. (44.5 × 109.5 × 187.3 mm)
Weight:	1.0 lb. (453.6g)
Power Requirements:	6 volts
Battery:	Four 1.5 volt (AA) cells
Line Supply:	110 volt AC
Test Voltage:	20 volts

AC Line Adapter (supplied)

Input:	120 volt AC 60 Hz 5 W
Output:	6 volts DC 150 mA

Important Notice to Purchaser:

Warranty—3M expressly warrants that for a period of ninety (90) days from the date of purchase 3M static control products will be free of defects in materials (parts) and workmanship (labor).

Defects occurring during the warranty period will be repaired or products will be replaced at 3M's option and expense, if 3M receives notice during the warranty period. Defective products must be returned to 3M with proof of purchase date.

Warranty Exclusions—THE FOREGOING EXPRESS WARRANTY IS MADE IN LIEU OF ALL OTHER PRODUCT WARRANTIES, EXPRESS AND IMPLIED, INCLUDING FITNESS AND MERCHANTABILITY. The express warranty will not apply to defects or damage due to accidents, neglect, misuse, alterations, operator error, or failure to properly maintain, clean, or repair products.

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3M

Operating Instructions

716
Wrist Strap Tester

INTRODUCTION

The 3M Model 716 Wrist Strap Tester is designed to measure a person's resistance while wearing a wrist strap assembly. The tester will indicate if a person is above or below a static safe resistance. It will also isolate defective areas within the wrist strap assembly. The user can quickly determine their resistance condition with the tester.

If a person's resistance to ground is too high, harmful levels of static electricity could be generated on the person's body. If it is too low, an electrical shock hazard could exist. The 716 tester is designed to indicate if a person's resistance is between 10 megohm and 500,000 ohms (internally set). If more accurate values are needed, a resistance measurement with an ohmmeter is required (please refer to pages 2 and 3, "Why Wrist Straps Are Needed And A Method For Testing Them).

INSTRUCTIONS

A. Testing the Batteries

Depress the metal contact plate fully. Observe the battery check lamp (amber). If the lamp is ON, the batteries are operational; if not, replace the batteries.

NOTE: The battery indicator lamp should be ON whenever the metal contact plate is activated. If the lamp turns off during a test, stop the test and replace the batteries.

B. Taking Measurements

Select the desired upper maximum resistance level with the selector range switch.

10MΩ – Ten Megohm maximum allowable resistance level for the total system (person included) to be static safe.

5MΩ – Five megohm optional resistance level. This level can be used to determine a more definite measurement if desired.

2MΩ – Two megohm resistance level used to test the ground cord.

Total System Test:

1. Connect the personnel ground cord (banana plug end or alligator clip end) to the identified terminal on the tester. With the personnel wrist band on the wrist, connect the other end of the ground cord (snap end) to the wrist band.

2. Depress the metal contact plate fully with the bare fingers of either hand and observe the PASS – FAIL indicator lamps.

   If the PASS (green) lamp is on, this indicates that the resistance being measured is less than the upper limit selected but greater than the minimum 500.000 ohms (internally set).

   If the FAIL (red) lamp is on, this indicates that the resistance may be greater than the upper limit selected or lower than the minimum 500.000 ohms (internally set).

   If both lamps are on at the same time, this indicates that the resistance of the wrist strap being tested is at the level selected by the selector range switch.

   NOTE: If the FAIL lamp turns on during the test, check to see if the personnel wrist band is being worn correctly. The band should fit the wrist snugly. (See instructions which were included with the purchase of the wrist band).

   If the FAIL lamp remains on, proceed to the CORD TEST.

CORD TEST

Leave the banana plug or alligator clip of the personnel ground cord attached to the tester. Disconnect the snap end of the ground cord from the wrist band and connect it to the identified terminal on the tester.

Select the 2MΩ level with the selector range switch.

Proceed as in step 2 of Total System Test above.

If the FAIL lamp is ON, replace the ground cord.

If the PASS lamp is ON, the ground cord is OK or check for other possible conditions in the system:

1. Intermittent continuity in the ground cord.

2. Intermittent continuity between the snap end of the ground cord and the wrist band.

3. Poor contact between the wrist band and the wrist (dry skin-hairy wrist) or defective wrist band.

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